Program Name : **Diploma in Instrumentation / Instrumentation & Control**

Program Code : **IS / IC**

Semester : **Fourth**

Course Title : **Industrial Transducers**

Course Code : **22432**

1. RATIONALE

In the industry, Instrumentation engineering diploma graduates (also called technologists) are expected to install, commission and maintain basic instruments used in the measurements of various parameters such as speed, force, thickness, vibration and sound. Many a time, they have also to interpret the specifications of these instruments. Often they have also to select the relevant instruments for the measurement of above parameters required for different applications.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain different types of transducers.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following ***industry oriented*** COs associated with the above mentioned competency:

a. Maintain the different types of speed measuring transducers.
b. Maintain the different types of force measuring transducers.
c. Maintain the different types of thickness measuring transducers.
d. Maintain the different types of vibration measuring transducers.
e. Maintain the different types of sound measuring transducers.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	2	4	10	3	70	28	30*	00	100	40	50#	20	50	20	100	40

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment*

5. COURSE MAP (with sample COs, Learning Outcomes i.e. LOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the

course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

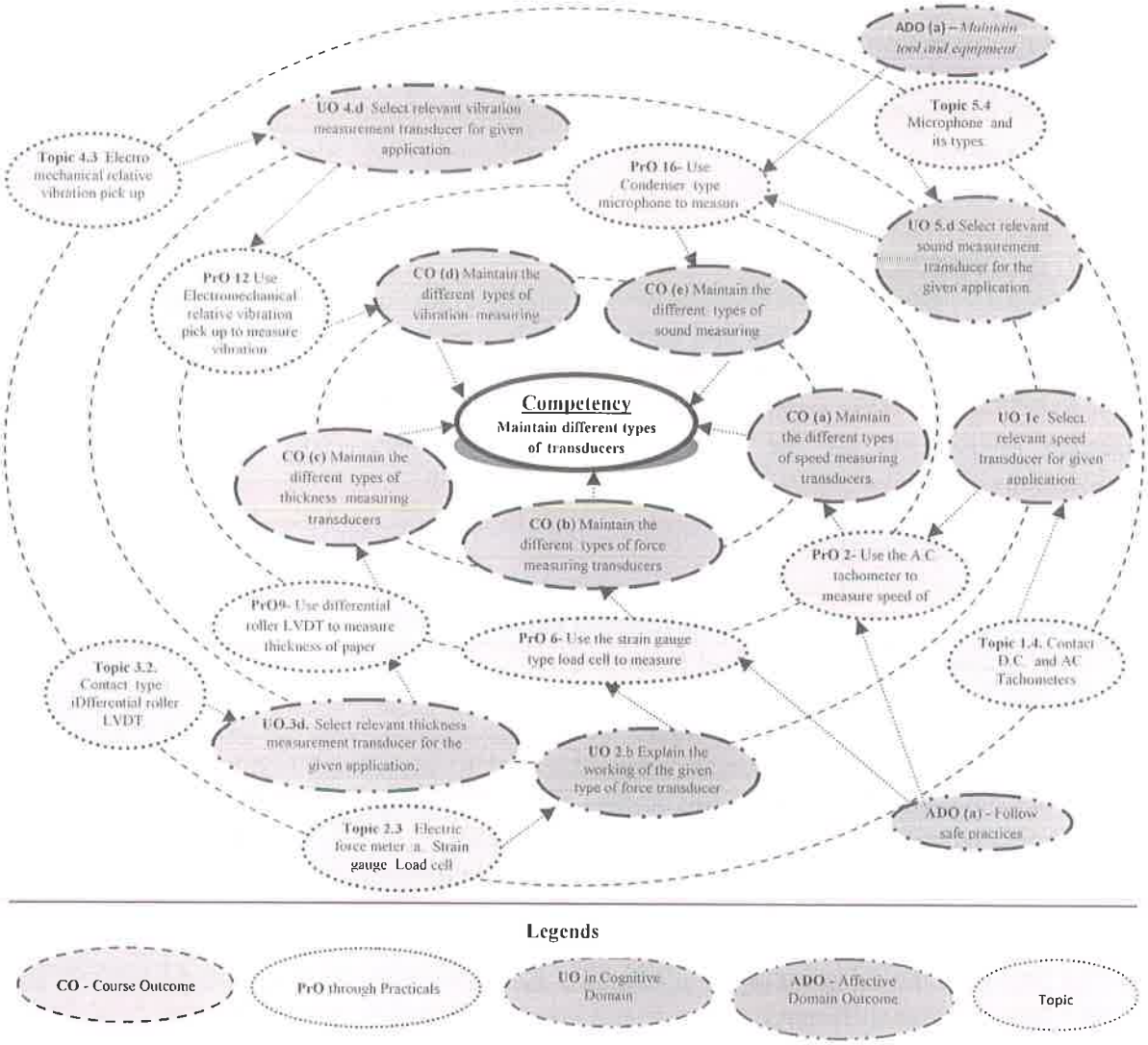

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Use the magnetic pickup proximity switch to measure speed of motor.	I	02
2			
3	Use the A.C. tachometer to measure speed of motor. Part - I	I	02
4	Use the A.C. tachometer to measure speed of motor. Part - II	I	02
5	Use the D.C. tachometer to measure speed of motor. Part - I	I	02*
6	Use the D.C. tachometer to measure speed of motor. Part - II	I	02
7	Use Optical Encoder for speed measurement. Part - I	I	02*
8	Use Optical Encoder for speed measurement. Part - II	I	
9	Troubleshoot the given speed transducer. Part - I	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
10	Troubleshoot the given speed transducer. Part - II	I	02
11	Use the strain gauge type load cell to measure weights. Part - I	II	02*
12	Use the strain gauge type load cell to measure weights. Part - II	II	02
13	Calibrate the weight measuring system using strain gauge type load cell. Part - I	II	02*
14	Calibrate the weight measuring system using strain gauge type load cell. Part - II	II	02
15	Assemble and Dismantle weight measuring system. Part - I	II	02
16	Assemble and Dismantle weight measuring system. Part - II	II	02
17	Use differential roller LVDT to measure thickness of paper. Part - I	III	02*
18	Use differential roller LVDT to measure thickness of paper. Part - II	III	02
19	Calibrate differential roller LVDT thickness measuring system. Part - I	III	02*
20	Calibrate differential roller LVDT thickness measuring system. Part - II		
21	Use relative displacement vibration pickup to measure vibration. Part - I	IV	02*
22	Use relative displacement vibration pickup to measure vibration. Part - II	IV	02
23	Use Electromechanical relative vibration pick up to measure vibration. Part - I	IV	02*
24	Use Electromechanical relative vibration pick up to measure vibration. Part - II	IV	02
25	Calibrate relative displacement vibration pick up vibration measuring system. Part - I	IV	02
26	Calibrate relative displacement vibration pick up vibration measuring system. Part - II	IV	02
27	Assemble and Dismantle relative displacement vibration pickup vibration measuring system. Part - I	IV	02
28	Assemble and Dismantle relative displacement vibration pickup vibration measuring system. Part - II	IV	02
29	Use digital sound level meter to measure intensity of sound. Part - I	V	02*
30	Use digital sound level meter to measure intensity of sound. Part - II	V	02
31	Use Condenser type microphone to measure sound. Part - I	V	02*
32	Use Condenser type microphone to measure sound. Part - II	V	02
33	Calibrate Condenser type microphone sound measuring system.	V	02
			66

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 24 or more practical need to be performed, out of which, the practicals marked as '' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
a.	Preparation of experimental setup	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observation and recording	10
e.	Interpretation of result and conclusion	20
f.	Answer to sample questions	10
g.	Submission of report in time	10
Total		**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
e. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. S.No.
1	**Speed measurement kit**: Inductive proximity/photoelectric pick-up, 3wire, 24 V DC. RPM - Supply voltage-230 VAC. Input from- inductive proximity or photoelectric pick-up Mounting- flush on panel front Display – 7 segments Red LED to measure speed of shaft of motor. AC/DC motors - Supply voltage:12 V/230 VAC FHP Speed: 1000 RPM – 1500 RPM Torque: ½ Kg.	1,5
2	**Speed measurement using A.C tachometer:** O/p Voltage: 3- 50 V at 1000 RPM, Type: 2/8 / 48 Pole, Imax: 50 ma, Max Speed: 4000 rpm. Mounting: Foot / Flange.	2
3	**Speed measurement using D.C tachometer:** Voltage Per 1000 r/min - 50V +/- 5%. Imax- 70mA at 200V, Max O/p Voltage - 200VDC, Max Speed Range - 4000rpm, Carbon Brush - 2 Nos Per Arm.	3
4	**Speed measurement kit**: Optical encoder for speed measurement 360 pulses	4

S. No.	Equipment Name with Broad Specifications	PrO. S.No.
	per revolution (PPR) optical encoder is mechanically coupled through a special coupling to 20 RPM D.C. motor (gear train) excited by 12 volt D.C. supply.	
5	**Weight measurement kit**: An industrial type of strain gauge type load cell with 50-kg capacity. Provision is made for two- arm and four-arm operation. Bridge balance controls in terms of coarse control and fine control are provided. An amplifier with variable gain in the range of 0 to 1000 is used for signal processing. Accuracy: +/- 1% with DPM indication.	6,7,8
6	**Thickness measurement kit:** LVDT type with thickness range 0 to 10mm, with accuracy of +/- 1%, with DPM Indication. Power supply 230Vac.	9,10
7	**Vibration measurement kit**: using accelerometer (piezo electric sensor with built in signal conditioning) can be used to measure peak to peak displacement of 2000 microns. The system is battery operated with LCD display.The vibration measurement can be carried out over a frequency range of 10HZ to 1KHZ.	10,11, 12,13, 14
8	**Sound Level meter:** Measuring range: 30 ... 130 dB, Accuracy: ± 1.4 dB, Frequency: 31.5 Hz ... 8 kHz, Frequency weighting: A and C.	15,16, 17

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Speed measurement	1a. Describe with sketches the construction and working of the given type of speed transducer. 1b. Differentiate the working of the given type of speed transducer with sketches. 1c. Select relevant speed transducer for the given application with justification. 1d. Prepare the specifications of the given speed transducer. 1e. Describe the calibration procedure for the given speed transducer. 1f. Describe the troubleshooting procedure of the given speed measurement transducer.	1.1 Speed and its units, types. 1.2 Contactless speed transducer. 1.3 Contactless Tachometers a. Magnetic pickup. b. Photo pickup. c. Stroboscope. d. Digital encoder. 1.4 Contact Tachometers a. D.C. Tachometer. b. A.C. Tachometer.
Unit– II Force measurement	2a. Describe with sketches the construction of the given type of force transducer with sketches. 2b. Explain with sketches the working of the given type of force transducer. 2c. Describe the calibration procedure for the given force transducer. 2d. Prepare the specifications of the given force transducer. 2e. Select relevant force transducer for the given application with justification. 2f. Describe the troubleshooting procedure of the given force measurement transducer.	2.1 Force and its units, Types. 2.2 Hydraulic force meter. 2.3 Electric force meter a. Strain gauge Load cell. b. Pressductor Load cell. c. Proving ring Load cell. d. Piezoelectric Load cell 2.4 Calibration of Strain

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		gauge Load cell weight measurement setup. 2.5 Conveyor belt weigh feeding system.
Unit– III Thickness measurement	3a. Describe with sketches the construction of the given type of thickness measurement transducer with sketches. 3b. Explain with sketches the working of the given type of thickness measurement transducer. 3c. Differentiate the given type of thickness measurement transducers. 3d. Select relevant thickness measurement transducer for the given application with justification. 3e. Prepare the specification of the given thickness measurement transducer. 3f. Describe the troubleshooting procedure of the given thickness measurement transducer.	3.1 Thickness and its units, Types. 3.2 Contact type : a. Differential roller LVDT. b. Inductive Pickup type. c. Capacitive Pickup type. d. Ultrasonic vibration type. 3.3 Noncontact type: Radiation type.
Unit-IV Vibration measurement	4a. Describe with sketches the construction of the given type of vibration measurement transducer with sketches. 4b. Explain with sketches the working of the given type of vibration measurement transducer. 4c. Differentiate the given type of vibration measurement transducers. 4d. Select relevant vibration measurement transducer for the given application with justification. 4e. Describe the calibration procedure for the given type of vibration measurement transducer. 4f. Prepare the specification of the given vibration measurement transducer. 4g. Describe the troubleshooting procedure of the given thickness measurement transducer.	4.1 Vibration and its units, types, common causes of vibration 4.2 Absolute vibration sensors. 4.3 Electro mechanical relative vibration pick up 4.4 Relative displacement vibration pick up 4.5 Electromagnetic relative vibration pick up. 4.6 Calibration of vibration pick up
Unit –V Sound measurement	5a. Describe with sketches the construction of the given type of sound measurement transducer with sketches. 5b. Explain with sketches the working of the given type of sound measurement transducer. 5c. Differentiate the salient features of the given types of sound measurement transducers. 5d. Select relevant sound measurement transducer for the given application with justification. 5e. Describe the calibration procedure of sound	5.1 Sound and its Units. 5.2 Sound pressure, sound power and intensity level. 5.3 Sound level meter. 5.4 Microphone and its types: a. Condenser type. b. Electrets type. c. Piezoelectric crystal

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	measurement measuring system. 5f. Prepare the specification of the given sound measurement transducer. 5g. Describe the troubleshooting procedure of the given sound measurement transducer.	type. d. Electro dynamic type. 5.5 Calibration of sound measuring system.

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Speed Measurement	10	02	04	08	14
II	Force Measurement	10	02	04	10	16
III	Thickness Measurement	08	02	02	06	10
IV	Vibration Measurement	10	02	04	10	16
V	Sound Measurement	10	02	04	08	14
Total		**48**	**10**	**18**	**42**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of LOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Prepare charts for measurements of various parameters such as speed, force, thickness, vibration and sound.
b. Prepare broad specifications for measurements of various parameters such as speed, force, thickness, vibration and sound.
c. Market survey for procurement of above transducers in point 'b'.
d. Prepare installation sketches of above transducers in point 'b'.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the

development of the LOs/COs through classroom presentations (see implementation guideline for details).

d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide students in undertaking micro projects.
f. Arrange visit to process industries and calibration workshops.
g. Use teaching aids such as videos/ YouTube of process industries.
h. Arrange expert lectures of industry person.
i. Instruct students to safety concern of handling various transducers.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Build digital speed indication circuit using Proximity switch.
b. Build digital weight indication circuit using strain gauge load cell.
c. Sound level meter for indication of intensity of sound in different environment.
d. Clamp switch project for Lamp ON-OFF.
e. Build digital vibration indication circuit using vibration pick.
f. Build Foot step power generator circuit using Piezoelectric crystal.
g. Build LVDT based circuit for thickness measurement of paper sheet and its digital indication.
h. Build capacitive sensor based circuit for thickness measurement of paper sheet and its digital indication.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electrical and Electronic Measurements and Instrumentation	Sawhney, A.K.	Dhanpat Rai and Sons, New Delhi . 2011; ISBN:9788177001006
2	Introduction to measurement and instrumentation	Ghosh, A.K.	PHI Learning, New Delhi , 2014; ISBN:9788120346253
3	Industrial Instrumentation and Control	Singh, S.K.	McGraw Hill Publishing Co. New Delhi , 2010 ISBN:9780070678200
4	Instrumentation,	Nakra,B.C;	McGraw Hill Publishing New

S. No.	Title of Book	Author	Publication
	measurement and analysis	Choudhry, K.K.	Delhi , 2015 ISBN:9780070151277
5	Instrumentation Systems and Devices	Rangan, C.S; Sharma, G. R ; Mani, S.V.	McGraw Hill Publishing Co. New Delhi , 2011 ISBN:9780074633502
6	Principles of Industrial Instrumentation	Patranabis, D.	McGraw Hill Publishing, New Delhi , 2010 ISBN:9780070699717
7	Process Measurement Instrument Engineers Handbook	Liptak, B.G.	Chilton Book Co U.S.A 1970 ISBN:9780750622547

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. http://webcache.googleusercontent.com/search?q=cache:o9gctY3KoVkJ:web.iitd.ac.in/~akdarpe/courses/MEL314/Fundamental%2520of%2520Noise.ppt+andcd=1andhl=enandct=clnkandgl=in
b. https://www.thermofisher.com.au/Uploads/file/Environmental-Industrial/Process-Monitoring-Industrial-Instruments/Sound-Vibration-Stress-Monitoring/Stress-Analysis/VishayMM/technology/technotes/Custom-Transducer-Design.pdf
c. https://www.engineersgarage.com/articles/speed-sensor-types?page=1
d. http://nritech.edu.in/eLearning/MECH-4-1/IV-I-MECH-AE-IandCS-Unit-5.pdf
e. http://www.kvc.com.my/StorageAttachment/Kvcsb/datasheet/945/mitutoyo-7327.pdf
f. ftp://ftp.unicauca.edu.co/Facultades/FIET/DEIC/Materias/Instrumentacion%20Industrial/Instrument_Engineers__Handbook_-_Process_Measurement_and_Analysis/Instrument%20Engineers'%20Handbook%20-%20Process%20Measurement%20and%20Analysis/1083ch7_20.pdf
g. https://www.bksv.com/media/doc/br0094.pdf
h. https://www.pce-instruments.com/english/measuring-instruments/test-meters/thickness-meter-kat_40043_1.htm
i. http://www.npl.co.uk/upload/pdf/forceguide.pdf
j. https://www.edx.org/course/subject/engineering


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